



# ARE WE ALONE IN THE UNIVERSE?

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01

# INTRODUCTION



**125,000 light years**

is the approximate length of the Milky Way

**93 billion light years**

is the approximate length of the universe

**10,000,000,000,000,000,000,000,000,000,000**

is the estimated number of planets in the universe

It seems impossible that we are the only  
life in all this space. Doesn't it?

# EXTRATERRESTRIAL LIFE

- One of the earliest known theories of extraterrestrial life was recorded in 200 AD by Lucian of Samosata, an ancient Greek satirist. While making a philosophical point of the impossibility of truth, Lucian wrote of discovering alien life on the moon.
- These lifeforms included men who sweat milk and sneeze honey, elephant sized fleas, and three-headed vultures.
- In modern times, aliens are often depicted as humanoid beings with varying features.
- The most asked question though, is not what these beings look like, but if they even exist, and how we can find them.



02

LIFE AND COSMIC  
EVOLUTION

# LIFE

- Logic suggests that since life evolved on Earth, extraterrestrial life will evolve on planets with the same conditions as Earth.
- However, the number of planets in the universe means that we can assume life has formed under different conditions.
- The differences between statistics of typical individuals and typical groups allow us to assume that the human race has a higher population than others without knowing anything about extraterrestrial races.

# From assuming that we are of one of the highest populations we can conclude that:

## Extraterrestrial life can survive on a planet smaller than Earth

This is because we know that life forms need space to live and as Earth holds more lifeforms, Earth will have a larger surface area.

## Extraterrestrial beings are likely larger than humans

This is because smaller living creatures need less space and energy to live and as Earth has a high population, it is assumed that humans will be smaller than extraterrestrial beings.

## The Earth's sun is brighter and closer compared to the star of an alien species

This is because available energy helps to maintain species of a higher population. Extraterrestrial species will have a smaller population, and therefore will not need as much energy.



# COSMIC EVOLUTION

- Cosmic evolution can be defined as the theory of the evolution and change of the universe and everything in it - beyond life on Earth.
- This was first theorized by Eric Chaisson in his 2001 book *Cosmic Evolution: The Rise of Complexity in Nature*.
- The theory of cosmic evolution links all evolution and helps scientists discover the interrelations between everything.

# Cosmic evolution links the evolution of:

Atoms and particles into stars and galaxies

Elements into molecules

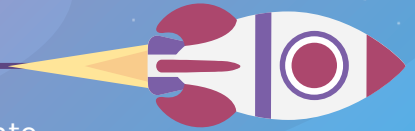
Advanced life into intelligent life

Primal energy into atoms and particles

Stars into heavy elements

Molecules into life

Intelligent life into technological civilizations



# COSMIC EVOLUTION AND EXTRATERRESTRIAL LIFE

- The theory of cosmic evolution states that there is a continuing flow of energy throughout all of evolution that originated from the Big Bang and that more complex systems have a greater degree of energy flow.
- This suggests that the energy that has spread throughout the universe has not localised itself to supporting life on Earth but supporting life throughout the universe.
- Additionally, it is almost impossible that the evolution of molecules to form life only occurred on Earth.

# IN SUMMARY

- Extraterrestrial life should not be expected to develop under the same conditions as life on Earth as there are millions of billions of planets that could potentially support alien life.
- Complex lifeforms have a greater energy flow according to cosmic evolution and it cannot be assumed that the only instance of such energy flow is on Earth.
- The timeline of cosmic evolution also suggests that molecules evolved into life, and it is extremely unlikely this only occurred on Earth.



03

# THE DRAKE EQUATION

# THE DRAKE EQUATION

- The Drake equation was created in 1961 by American astrophysicist, Frank Drake. Drake is the former chairman of the Search for Extraterrestrial Intelligence (SETI) Institute and has many other notable credentials.
- The Drake equation estimates the number of advanced and detectable civilizations there should be in the Milky Way at any time.

The Drake equation is:

$$N = R_* \times f_P \times n_e \times f_l \times f_i \times f_c \times L$$

$N$

The number of civilizations with detectable electromagnetic emissions

$R_*$

The mean rate of star formation

$f_P$

The fraction of these stars that have planetary systems

$n_e$

The mean number of these planets with suitable conditions to support life

$f_l$

The fraction of suitable planets that develop life

$f_i$

The fraction of these planets that evolve to have intelligent life

$f_c$

The fraction of intelligent civilizations that produce detectable signs of communication

$L$

The mean length of time that these civilizations can communicate

Many of the variables in the Drake equation are hard to find and always changing, but there are a number of missions with goals of finding the answers.

## THE ALLEN TELESCOPE ARRAY (ATA)

- The ATA is a radio telescope that is being used by SETI to search for intentional cosmic transmissions which may be sent by extraterrestrial life.
- It is made up of 42 satellite dishes and antennae, with each antenna being slightly offset to reduce interfering waves.
- Radio signals are reflected from the primary reflector onto the secondary mirror to be sent to the feed antenna. The signals are amplified and sent back to control buildings through an optical fiber.
- The ATA system can detect frequencies between 1,000 and 15,000 MHz in one primary beam that prevents detection of terrestrial interference.
- The ATA allows SETI scientists to observe several star systems 24 hours a day.



Allen Telescope Array (Seth Shostak 2012)



## NASA'S TESS MISSION

- NASA'S TESS mission is a mission using the Transiting Exoplanet Survey Satellite (TESS) to search for planets outside of our solar system that may have suitable conditions to support life.
- TESS launched on the 18<sup>th</sup> of April 2018 and has currently cataloged over 2,200 exoplanets as of March 23, 2021.
- TESS surveys sections of the sky using powerful cameras to study stars and the planets orbiting them.
- TESS also detects exoplanets by observing the dips in the light of a star, or a transit, which may indicate the presence of a planet orbiting the star.
- Earlier this year, TESS discovered the first Earth-sized planet in a habitable zone, located in a planetary system called TOI 700 about 100 light years away.

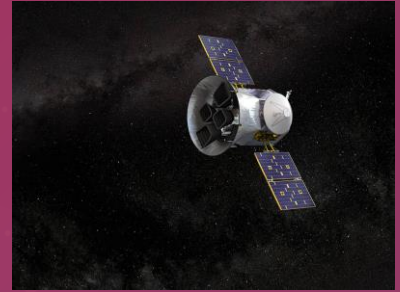


Illustration of NASA'S TESS  
(NASA'S Goddard Space Flight  
Center 2017)



The first Earth-sized  
habitable planet  
discovered by TESS  
(NASA/Goddard  
Space Flight Center  
2020)

# IN SUMMARY

- The variables of the Drake equation are constantly changing, but scientists are getting closer to finding each number every day.
- However, one variable is the mean number of planets with suitable conditions to support life. This means similar conditions to those on Earth, although it was earlier discussed that alien life may exist outside of these conditions, so this equation may not be entirely accurate.
- If the Drake equation can someday be solved, we may be able to calculate the number of intelligent societies that co-exist with humans and that we could communicate with in the Milky Way galaxy.

The background is a vibrant, abstract space scene. It features a color gradient from red on the left to blue on the right. There are several stylized planets: one with blue and green stripes in the top left, one with orange and brown stripes in the bottom right, and a large white planet with blue spots on the right side. Numerous small white stars and purple nebulae are scattered throughout the scene.

04

CONCLUSION

# CONCLUSION

- The evolvment of life, cosmic evolution, and the Drake Equation all suggest that extraterrestrial life exists, has existed or will exist in the future.
- We should not assume, however that alien life will have developed under the same condition as ours, or that they will look or live anything like us; they may physically be much larger and live in smaller populations than humans.
- We are still looking for signs of extraterrestrial life in various ways, but we never know when we will stumble onto evidence of extraterrestrial life.



# Thank you

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